AD-A066 004 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 9/6

RADIOTELEMETRY OF MAN-MADE SATELLITE, (U)

MAR 78 W LING-YAO

UNCLASSIFIED FTD-ID(RS)T-0044-78 NL

1 OF 1

ADA

066004

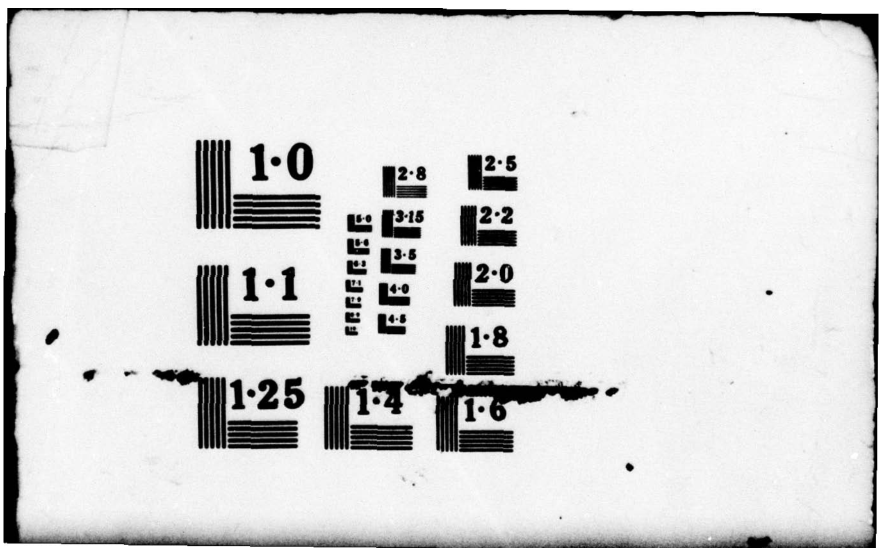
END

DATE

FILMED

5 79

DDC


1·0
2·8
2·5
3·15
2·2
3·5
1·1
2·0
4·0
4·5
1·8
1·25
1·4
1·6

AD-A066004

FTD-ID(RS)T-0044-78

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

RADIOTELEMETRY OF MAN-MADE SATELLITE

by

Wu Ling-yao

FOREIGN TECHNOLOGY DIVISION

78 12 22 132

EDITED TRANSLATION

FTD-ID(RS)T-0044-78 6 March 1978

MICROFICHE NR: FTD-78-C-000296

RADIOTELEMETRY OF MAN-MADE SATELLITE

By: Wu Ling-yao

English pages: 11

Source: Hang Kung Chih Shih, No. 5, 1977, pp 13-15.

Country of origin: China
Translated by: LINGUISTIC SYSTEMS, INC.
F33657-76-D-0389
H. P. Lee
Requester: FTD/SDSY
Approved for public release; distribution unlimited.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

Radiotelemetry of Man-made Satellite
By
Wu Ling-yao

Many comrades reflect that the science of radiotelemetry is very difficult to understand and they have only some general idea about it. Sometimes it seems that they understand but they really do not, and often they are confused by the mathematic formulas and electronic circuits. This article attempts by not using mathematic formula and electronic circuits to introduce some basic knowledge of telemetry of a man-made satellite, and hopes that it will enable us to understand how people on the earth can know all the situations of a satellite and how a satellite can transmit the data collected to the earth. Because this article is rather long, it will be published in two consecutive issues of this journal.

In space a satellite is flying, far away it is from us. Anyone wants to know what is going on there, only the marvelous power of telemetry can declare.

A satellite is invisible and untouchable when it is flying in space high above from several hundreds to several ten-thousand kilometers from the earth. Whether the temperature and pressure inside the satellite change regularly as designed and whether the equipment in the satellite function normally? These are the questions which concern those who are working on ground station. The final criterion that determines the success or failure of launching a satellite is whether the satellite can work normally for a long period of time in high vacuum, hyperlow temperature and the space

condtion of strong radiation when it is carrying the main section of a missile and under the rough condition of impact, shaking and noise. It is ratiotelemetry by which people on the ground station can check the man-made satellite in space and the working conditions of the equipment in it.

Some man-made satellite is launched for the purpose of making scientific research, some for mapping natural resources and still some for military reconnaissance. In carrying out these missions, the satellite must unceasingly send back to the earth the data collected from its exploration and survey. It is the radiotelemetric system in a satellite, which performs such tasks.

Telemetry means a method of making survey of objects at a long distance. A telemetric system is one which is used to make long distance survey and communication. By using a telemetric system, people on the earth can learn the working conditions inside a satellite thousands of miles away as well as the environmental conditions outside it. The contents of survey and communication made by a telemetric system are called telemetric parameter. There are two different kinds of telemetric parameters: one is engineering parameter, which is used to supervise the working conditions of the satellite and the equipment in it, such as temperature, pressure, voltage, electric current, rotating speed, acceleration and attitude angle; and the other is exploration parameter obtained by the explorer and the distant-sensor in the satellite, such as sun short wave radiation and particle radiation, earth infrared radiation, atmosphere density, earth's magnetic field, cosmic radiation, micrometeoroids and pictures of various wave bands of earth, clouds and sun taken by the satellite.

The Composition of a Telemetric System

Most of the engineering and exploration parameters are non-electric but physical quantity. The first step of telemetering is to survey these physical quantities and convert them into voltage signals, and this is done by the sensor, explorer and distant-sensor in a satellite. The second step is to use high frequency radio wave to send out these voltage signals, which represent telemetric parameters, and this is done by the emittor in a satellite. Third step is to use a receiver on ground to receive the high frequency electric wave, sort out the telemetric signals brought down by the high frequency electric wave and then change these signals to telemetric parameter according to the changes of the signal voltage.

The elemetric system in a satellite is simply composed of a sensor and an emittor. From a telemetric point of view, the explorer and the distant-sensor are a kind of sensor, because the function of them both is no more than converting the surveyed physical quantities into voltage signals based on a certain ratio. A temperature sensor, for example, is made of thermo-couple and put at a place where thermometering is needed. It is very sensitive to temperature change and gives a voltage signal which is in a direct proportion to the temperature. Also a magnetometer, for

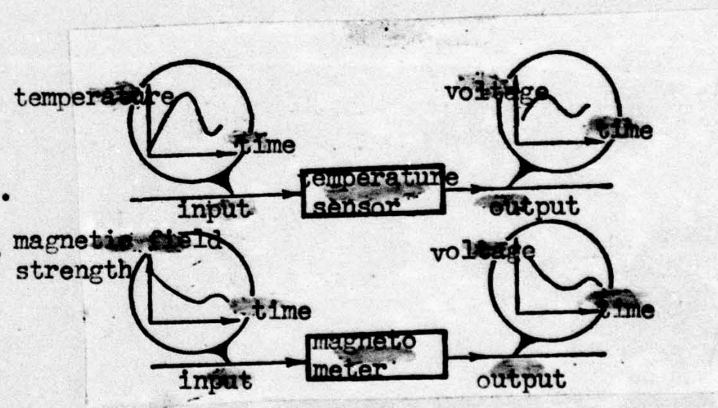


Figure 1 Diagram of inputing and outputing of signals by a sensor

example, is an explorer used to investigate the magnet field strength of the earth. As a satellite is at different position and altitude with the earth, the strength of the earth's magnet field is different. The magnetometer gives a voltage signal that is in a direct proportion to the strength of the earth's magnet field (Figure 1). The sensors used in a satellite (including explorer and distant sensor) are of various kinds and the scope of their uses is rather broad. According to the objects they surveyed, they can be classified as follows: temperature sensor, pressure sensor, acceleration sensor, infrared horizon, angle and angular speed sensor, scinticounter and proportional counter which are used to measure the strength of particle radiation, microradiometer, infrared radiometer, ultraviolet radiometer, air pressure gauge, camera of various wave bands, pick-up tubes and pictorial radar. According to their working pricinples, they are of the following types: electric resistance, electric induction, electric capacity, magneto-elasticity, generator, photo-electricity, electronic tube, radiation and other combined types.

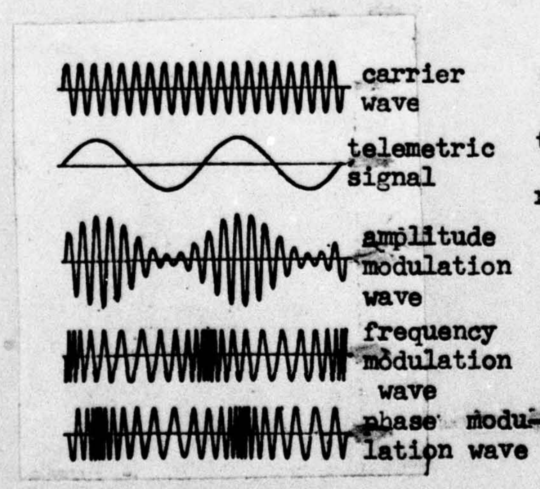


Figure 2 Diagram of the forms of three modulated waves

The emittor in a satellite is a power station from which the telemetric signals are sent out by radio waves. The greater the efficiency of emitting is, the easier can they be received on the ground. Like other equipment in a satellite, the emittor is required to be of light weight and small size, and consume less energy. Certainly it can by no means

be as large and complicated as an emittor a radio station on the ground can have. As the emitting efficiency is much limited, it can reach only several tens of milliwatts or simply several milliwatts. For this reason, a ground receiver must be very highly sensitive. The radiotelemetric system of a satellite is just contrary to a radio broadcasting system on ground. The emittor is small and the receiver is large. Of a radio broadcasting system on ground, the emittor is large and the receiver can be small.

Modulation and Demodulation

The principles of emitting telemetric signals from a satellite are similar to that of emitting sonic frequency signals from a radio broadcasting station. Generally speaking, the change of telemetric signals is very slow and their frequency is low. So they cannot travel in space by themseves nor can they be transmitted unless they are loaded on high frequency radio waves. This is just like some goods must be loaded on a vehicle to be transported. To load the low frequency telemetric signals on high frequency radio wave requires special techniques. In radio technology, such a practice of loading is called "modulation". The characteristics of radio wave are often indicated by the quantity of amplitude, frequency and phase. If the amplitude of high frequency radio wave is made to change according to the size of telemetric signals, the trace of the change forms a curve similar to that of the telemetric signals. This process of "reforming" high frequency radio wave according to the changes of telemetric signals is modulation, and the "reformed" high frequency radio wave is called carrier wave. That which makes the amplitude of carrier wave change based on telemetric signals is called amplitude modulation, and that which makes the frequency of

carrier wave change based on telemetric signals is called frequency modulation. The carrier wave of modulated frequency has a center frequency. When the telemetric signal voltage is zero, the frequency of the carrier wave is a center frequency. When the signal voltage is positive, the frequency of the carrier wave is higher than the center frequency; when the signal voltage is negative, the frequency of the carrier wave is lower than the center frequency. If the phase of the carrier wave changes as telemetric signals require, it is called phase modulation (Figure 2).

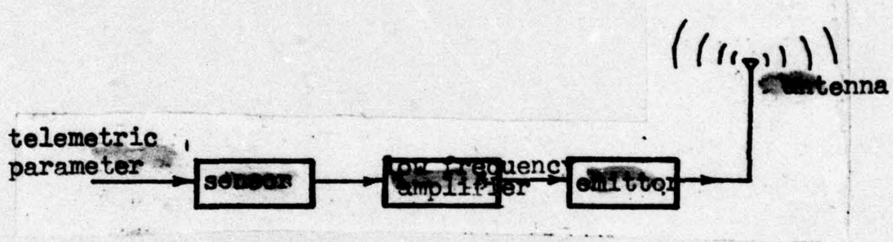


Figure 3 Diagram of the process of sending telemetric parameter from a satellite

The emittor on a satellite has a high frequency oscillator, which can emit stable and high frequency radio wave. This frequency is the center frequency of the carrier wave. The telemetric signal sent out by sensor, after amplification, will modulate the high frequency oscillation of the emittor, and the modulated high frequency oscillation—carrier wave will be emitted through antenna (Figure 3).

In space, between 50 and a few hundred miles high above the earth, there is an electric disassociation layer, and in this layer, radio waves can be reflected and absorbed. If the radio wave set out from a satellite wants to reach the earth through this electric disassociation layer without being absorbed or reflected back, it must be hypershort wave or microwave

of which the wave length is small (less than 10 meters).

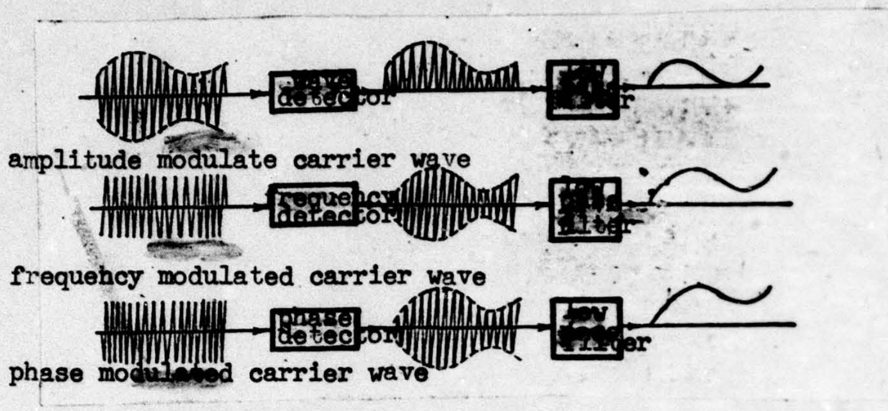


Figure 4 Diagram of the process of carrier wave modulation

When the carrier wave set out from a satellite has been received by a receiver on ground, the telemetric signals must be"unloaded" from the carrier wave. The process of "unloading", which is contrary to the "loading" (modulation) in the emittor in the satellite, is called demodulation. If the carrier wave of the telemetric signals is amplitude modulated, the principles and equipment used for demodulation on ground are just like those applied to an ordinary radio. The process of demodulation is a process of detection. If the carrier wave is frequency modulated or phase modulated, there must be a frequency detector or a phase detector to demodulate the telemetric signals from the frequency modulated carrier wave or the phase modulated carrier wave. The frequency detector converts frequency change of the frequency modulated wave into voltage amplitude change, and the phase detector converts phase change of the phase modulated wave into voltage amplitude change. Then the telemetric signals are filtered out through a low pass wave filter (Figure 4).

When radio wave is interfered by the straying electric waves during

the transmission through a long distance, its amplitude often produces some irregular changes. To the amplitude modulatedwave, the effect of interference is a kind of extra modulation. However, it can become an error when it is reflected in the telemetric signals obtained after demodulation. This kind of interference of the straying electric waves is always there and can by no means be eliminated. But to the waves of frequency modulated and phase modulated, the interference is not a seriuos problem. Even though the interfering electric waves can cause additional change in amplitude, on ... ground to receive carrier waves can use an amplitude controller to cut down the amplitude of the carrier waves. Thus the effect of the interference is basically eliminated in demodulation,and the telemetric signals can be relatively accurate (Figure 5). So for carrier wave modulation in a satellite telemetering , frequency modulation and phase modulation are often adopted.

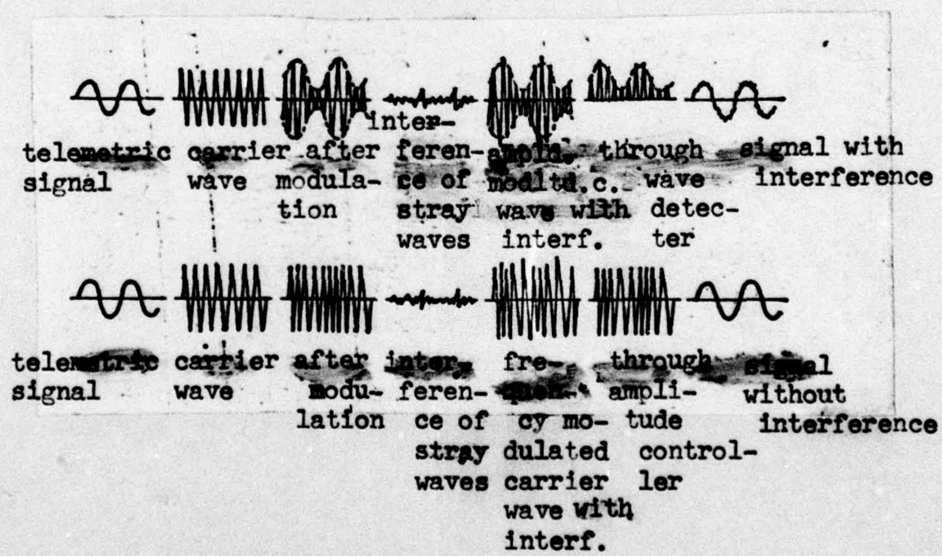


Figure 5 Situations of amplitud modulated carrier wave under interference and frequency modulated carrier wave without interference

Real Time Telemetering and Delayed Telemetering

People always hope that they can at any time know the working conditions of the equipment in a satellite and the activities of the satellite, and analyze the data collected by the satellite. As a matter of fact, some of the parameters and signals that are related to the telecontrol order can be effective only if they are comprehended immediately at a required time and place without delay. The confirming signal and executive signal in the telecontrol order, for example, must be grasped immediately without any delay before starting the engine, and so is the attitude angle parameter before trying to adjust the attitude. On some occasion, some of the engineering parameters in a satellite should continuously enter into the computer network on the ground so as to form a closed return path for the satellite telecontrol. All these require that a telemetric system is able to make survey on one hand and to emit and receive on the other. This means that the telemetric signals sent forth by the sensor must be immediately modulated on an emittor and the emittor emits caarier wave promptly. These telemetric parameters can be then received and demodulated instantly on the ground and finally they are recorded and revealed. Telemetering in this manner is called real time telemetering.

A real time telemetering can take place only when a satellite is flying in the space over the vicinity of the ground station. But satellites all the more often are out of sight of ground receiving station, and sometimes they go to the other side of the earth opposing to the ground station. Because the transmission of hypershort wave and microwave is always made on a straight line and no deflection, if a satellite is on the other side of the earth, a ground receiving station on this side cannot receive the

carrier wave emitted from the satellite, and the real time telemetering is therefore interrupted. Under such condition, the satellite often puts the telemetric signals issued from the sensor into a storage. When it flies back to the area where the ground receiving station can function, the ground station issues telecontrol order, and the satellite opens the storage, releases the stored telemetric parameters and send them through an emittor to the ground (Figure 6). Telemetering in such a fashion is called a delayed telemetering.

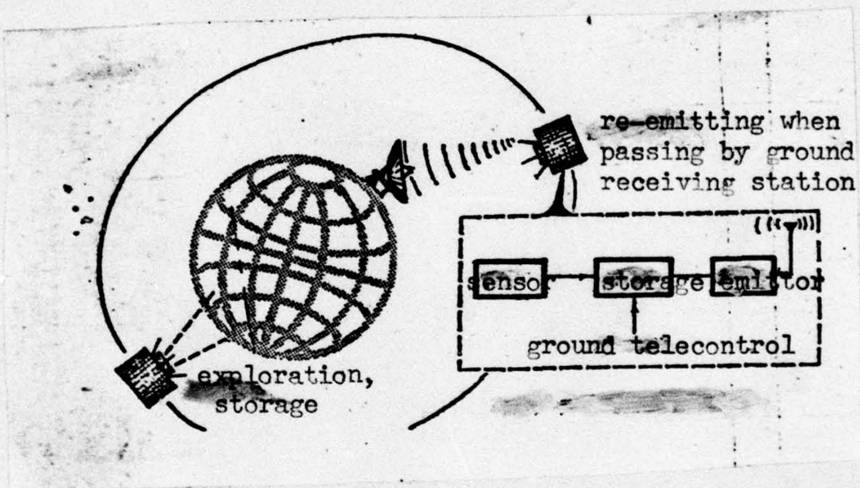


Figure 6 Diagram of the process of delayed telemetering

The data storage used by a satellite is of two different kinds: one is the magnetic tape as used in recorders, and the other is magnetic core as used in computers. Both of them can be used for the purpose of storing and releasing for a great number of times.

The delayed telemetering can be adopted as a complement to the shortcomings of the real time telemetering. It can supply telemetric parameters during the time when a satellite cuts off connection with a ground receiving

station. So the ground station can have the complete record of the working conditions of the satellite and complete intelligent data collected by the satellite through its whole journey.

It seems posible to use another satellite as a continuing station to solve the problem of discontinuance in a real time telemetering by a satellite around the earth. This idae is now under research and study.

(to be continued)

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION		MICROFICHE
A205	DMATC	1
A210	DMAAC	2
B344	DIA/RDS-3C	8
C043	USAMIIA	1
C509	BALLISTIC RES LABS	1
C510	AIR MOBILITY R&D LAB/FIO	1
C513	PICATINNY ARSENAL	1
C535	AVIATION SYS COMD	1
C591	FSTC	5
C619	MIA REDSTONE	1
D008	NISC	1
H300	USAICE (USAREUR)	1
P005	ERDA	1
P055	CIA/CRS/ADD/SD	1
NAVORDSTA (50L)		1
NASA/KSI		1
AFIT/LD		1

ORGANIZATION		MICROFICHE
E053	AF/INAKA	1
E017	AF/ RDXTR-W	1
E404	AEDC	1
E408	AFWL	1
E410	ADTC	1
E413	ESD	2
	FTD	
	CCN	1
	TQIS	3
	NIA/PHS	1
	NICD	2